Chapter 8
Relief Well Installation

8-1. General Requirements

Proper installation of relief wells is essential to the successful protection of the structures for which they are designed to protect. Before installation is begun, all materials required for completion of the installation should be on hand at the worksite. The well screen and riser should be checked for proper material, length, diameter, and slot openings. The filter material should be inspected and checked against gradation specifications. Successful completion of a well installation is often dependent upon time, and many installations have been aborted because of delays. An open boring of sufficient size and depth is necessary to facilitate the installation of a well. The hole should be vertical so that the screen and riser may be installed straight and plumb. As previously discussed, the hole is drilled large enough to provide a minimum thickness of 4 to 6 in., depending on the gradation, of the filter material. The methods of providing an open boring in the ground are numerous; however not all are acceptable for the installation of permanent relief wells, and those considered acceptable are discussed in the following paragraph.

8-2. Standard Rotary Method

One method of drilling for well installation which has gained popularity in the well drilling industry is standard rotary drilling using a biodegradable, organic drilling fluid additive. No bentonitic clays are used in the drilling fluid. Standard rotary drilling consists of rotating a cutter bit against the bottom of a boring, while a fluid is pumped down through the drill pipe to cool and lubricate the bit and return the cuttings up the open hole to the ground surface. The required size of bit is governed by the screen diameter and the thickness of filter. The ability of the fluid to carry the cuttings is dependent on its velocity and viscosity. The velocity of the returning fluid is reduced with increased boring diameter, and the reduction is compensated by increased viscosity of the drilling fluid. One such drilling fluid additive is marketed under the trade name "Revert," so-called because the fluid reverts to the viscosity of water, normally in about three days. Chemicals can be added to speed up or delay the reversion of such fluids as "Revert." Ground-water temperatures may effect reversion times.

a. Equipment. A rotary-type drill rig of sufficient hoisting and torque capacity is required. The cutter or drill bit can be of either drag or roller design. The drill pipe should be as large as practicable to increase the volume of fluid at the drill bit and, consequently, the velocity of the fluid returning up the open hole.

b. Problems. The reverting process of the drilling fluid leaves a small amount of slimy ash which, unavoidably, is mixed into the filter material; however a large percentage of this ash is removed during development of the well. Testing to determine the extent of detriment caused by this ash residue has not been sufficient to evaluate the effectiveness of this method; however it has been used successfully in installation of permanent relief wells. Chemical development of the well is required as subsequently described.

8-3. Reverse-Rotary Method

This method is generally considered to provide the most acceptable drill hole and should be used whenever possible for the installation of permanent relief wells. In the reverse-rotary method, the hole for the well is made by rotary drilling, using a similar cutting process as employed in standard rotary drilling except the drilling fluid is pulled up through the drill pipe by vacuum and the drilling fluid reenters the top of the open boring by gravity. Soil from the drilling is removed from the hole by the flow of drilling fluid circulating from the ground surface down the hole and back up the hollow drill stem from the bit. Since the cross-sectional area of the boring is many times larger than that of the drill pipe, the slow downward velocity of the fluid acting against the open boring does not erode the walls. The drilling fluid consists of water and, unavoidably, a small amount of the finer fraction of the natural material being drilled. A high velocity is attained with the fluid returning up through the drill pipe, thus eliminating the need for a high viscosity. The drill water is circulated by a centrifugal or jet-eductor pump that pumps the flow from the drill stem into a sump pit. As the hole is advanced, the soil particles settle out in the sump pit, and the muddy water flows back into the drill hole through a ditch cut from the sump to the hole. The sides of the drill hole are stabilized by seepage forces acting against a thin film of fine-grained soil that forms on the wall of the hole. A sufficient seepage force to stabilize the hole is produced by maintaining the water level in the hole at least 7 ft above the natural water table. Figure 8-1 shows schematically the circulating system for

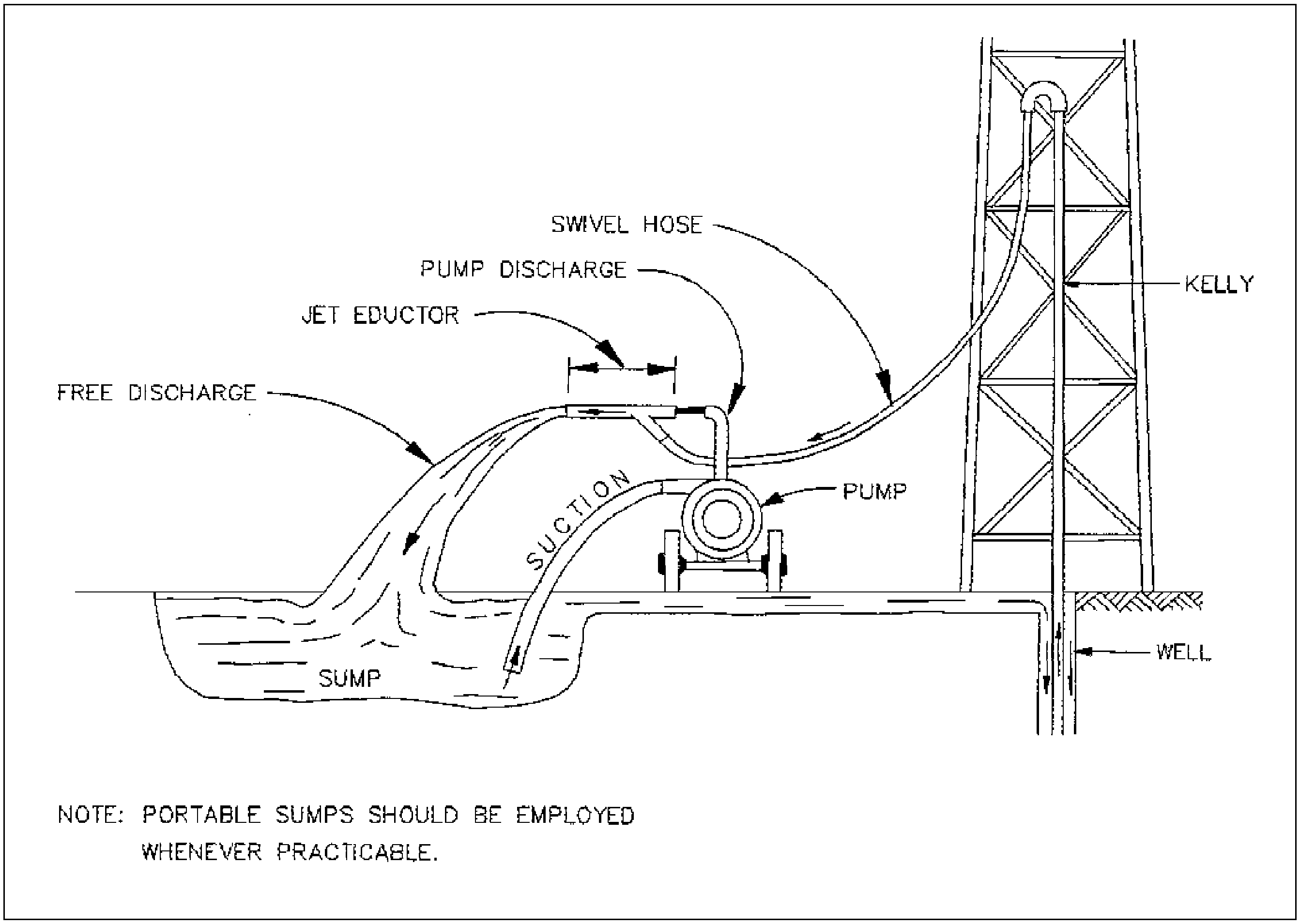

Figure 8-1. Schematic diagram of circulatory system (after EM 1110-2-1913)

reverse-rotary drilling. No bentonitic drilling mud should be used because of gelling in the filter and aquifer adjacent to the well. If the hole is drilled in clean sands, some silt soil may need to be added to the drilling water to attain the desired degree of muddiness (approximately 3,000 ppm). A biodegradable organic drilling fluid additive such as "Revert" or equivalent may also be added to the drilling water to reduce water loss.

a. Equipment. Reverse-circulation rotary drilling requires somewhat specialized equipment, most of which is commercially available or easily fabricated. Any rotary-type drill rig large enough to handle the load and having sufficient torque capability can be adapted to circulate water through an eductor to create a vacuum on the drill pipe. Drill pipe and hoses should be of a constant inside diameter throughout the system to assure that material entering the system can be circulated completely through it. In alluvial deposits, a drag-type bit similar to the cutter head for a dredge is sufficient. Roller-type bits are commercially available for use in consolidated deposits. The eductor consists of a pipe Y with a nozzle fitted into one end of the Y.

b. Problems. It is necessary to maintain an excess hydrostatic pressure on the drill hole to stabilize the walls. In most materials, a minimum excess head of 7 ft is required and greater is desirable. When the static water level is very near the ground surface or artesian conditions prevail, it may be necessary to elevate the drilling rig on temporary berms. Some success has been experienced by lowering the water level with well points, but if the pressure is derived from a deeper, artesian source, it is necessary to lower the pressure in the aquifer with deep wells. Since the formation in which a well is installed consists predominately of granular material, the loss of water into the formation presents a problem during drilling. An almost unlimited supply of water can be necessary to maintain a completely filled, open boring. A large sump is required to supply adequate water. During the drilling, all cuttings from the boring are deposited in the sump and must be provided for. A sump three times the anticipated volume of the completed boring is adequate, if it can be kept filled with water from another source. Consideration should be given to the required thickness of the natural impervious clay blanket when constructing a sump. An instantaneous loss of water resulting in loss of excess head can cause failure of the boring walls. Often, if the rotation of the drill bit is stopped, the water loss is greatly reduced. The boring must be kept full of water until the well screen, riser, and filter are installed.

8-4. Bailing and Casing

In cases where standard or reverse-rotary drilling is not successful, an equally acceptable method of drilling consists of bailing while driving a steel casing into the hole to stabilize the boring walls. This method is economical in some materials, and it does not inject deleterious materials into the formation. Loose to medium dense, clean, granular materials can be bailed economically. Often the granular materials are overlain with a cohesive overburden which does not yield easily to bailing, and it is more economical to auger through this overburden.

a. Equipment. A drill rig with a wire line hoist and driving capability is adaptable to this method of well installation. It should be remembered that large casing, heavy enough to sustain driving, presents a sizable load to be handled by the drill rig. The use of a vibratory pile driver can greatly facilitate the driving and subsequent removal of the casing. The casing should be flush-joint, or welded-joint steel pipe. Two types of bailers are commonly used for this purpose (Figure 8-2). Details are given in EM 1110-2-1907. The bailer is operated on a wire line by lowering to the bottom of the boring and quickly pulling, or snatching, up a short distance a number of times to fill the bailer.

b. Problems. This method of drilling produces good results but often presents problems in operations. Thin layers of cohesive materials, or cemented materials within the formation, can preclude the advance by bailing and may also produce smear along the sides of the drill hole which could impair free flow into the well. Penetration of the casing can be retarded by friction of the granular formation against the outside of the casing unless vibratory hammers are used. After the casing is set, the boring completed, and the well installed, the casing is removed. The casing should be pulled, as the filter material is placed, to prevent disturbing the well installation by the friction of the filter material inside the casing. Using a vibratory pile hammer to drive and extract casing can densify loose foundation materials and filter materials. Generally, when material is densified, the hydraulic conductivity is reduced. The vibratory hammer cannot be used in wells that have more than one filter pack. As densification in the filter pack occurs, the material settles. This settlement, combined with settlement which occurs as the filter fills the void left by removal of the casing, results in uncertainties regarding the final position of the top of the filter. There are many uncertainties associated with this method of installation which makes it very difficult to estimate time and costs.

8-5. Bucket Augers

Under certain conditions drill holes for relief wells can be made with a bucket auger. The method has been successfully employed where cobbles up to 10 in. have been encountered. A bucket with side cutters is employed, and only water is used as the drilling fluid. The rate at which the bucket is inserted or withdrawn must be carefully controlled; thus close inspection is obligatory. A steel casing is installed through the top stratum to prevent smearing of fine-grained materials on the walls of the drill hole.

8-6. Disinfection

Before drilling begins, all tools, rods, bits, and pumps should be thoroughly washed with a chlorine solution to kill any bacteria remaining from previous well installations. Water used in the drilling process and filter materials should also be treated with a chlorine solution (Driscoll 1986). The strength of the chlorine solution should not be less than 100 ppm, which means a proportion of 100 lb of chlorine to 1 million lb of water. Calcium hypochlorite which contains 65 percent available chlorine is commonly used for this purpose. The required weight (wt) of calcium hypochlorite to produce

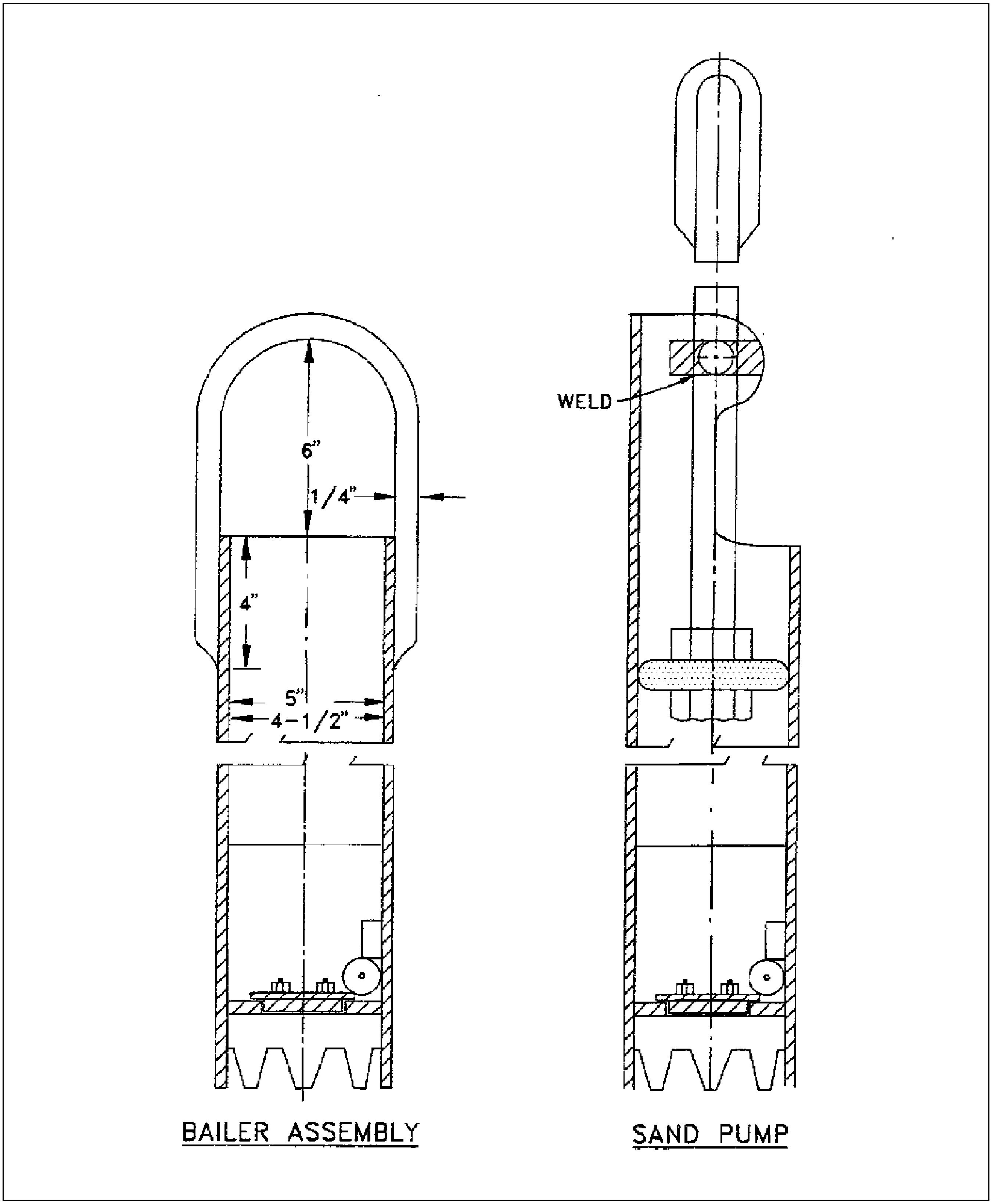

Figure 8-2. Bailer and sand pump assemblies (after EM 1110-2-1907)

a given strength in N gallons (gal) of water is given by the equation

$$Wt\ (lb) = N\ (gal) \times 8.33 \times \frac{solution\ strength}{available\ chlorine} \qquad (8\text{-}1)$$

where both solution strength and available chlorine are expressed as a decimal. Thus, for a chlorine solution of 100 ppm in 1,000 gal of water, using calcium hypochlorite with 65 percent chlorine, the required weight of calcium hypochlorite is

$$Wt\ (\text{lb}) = 1{,}000\ (\text{gal}) \times 8.33 \times \frac{0.0001}{0.65} = 1.28\ \text{lb}$$

Similarly, for chlorine products such as sodium hypochlorite which is available in gallons, the required volume (V) to produce a given strength in N gal of water is given by the equation

$$V\ (\text{gal}) = N\ (\text{gal}) \times \frac{solution\ strength}{available\ chlorine} \qquad (8\text{-}2)$$

Thus, for a chlorine solution of 100 ppm in 1,000 gal of water using sodium hypochlorite with 10 percent available chlorine, the required volume of sodium hypochlorite is

$$V\ (gal) = 1{,}000\ (\text{gal}) \times \frac{0.0001}{0.10} = 1.0\ \text{gal}$$

8-7. Installation of Well Screen and Riser Pipes

Once the boring is completed and the tools withdrawn, the boring should be sounded to assure an open hole to the proper depth. The well screen and riser pipe can be fabricated at the factory in varying lengths. The contractor will determine these lengths based on the capacity of his equipment. The bottom joint of the well screen should be fitted with a cap or plug to seal the bottom of the screen. The lengths of screen are connected together as they are lowered into the hole. Each length must be measured to determine its total made-up length, and the bottom of the screen should be set at the designed depth, or as field conditions require. The method of connecting the lengths of screen and riser vary: metal screen and riser have threaded or welded joints; plastic and fiberglass screens usually have either mechanical or glued joints. Each joint should be made up securely to prevent separation of the well during installation and servicing activities. Each joint should be kept as straight as possible to facilitate ease of servicing and testing. The riser and screen sections of the well should be centered in the drill hole by means of appropriate centering devices to facilitate a continuous filter around the well screen. If materials appreciably finer than anticipated in design are encountered, design personnel should be notified. In such cases, it may be necessary to replace the screen by a solid pipe or blank screen to prevent piping of foundation materials into the well. Immediately after installation of the well screen and riser, the total inside depth should be sounded. The exact inside depth of the well must be known to determine whether damage occurs during development and servicing of the well.

8-8. Filter Placement

Caution in proper design, control of manufacture, and handling of filter materials to the jobsite can be completely negated by improper placement in the well. Acceptable construction of permanent relief wells demands that the filter be placed without segregation because widely graded filters when placed in increments tend to segrate as they pass through water, with coarse particles falling faster than fine particles. A tremie should be used to maintain a continuous flow of material and thus minimize segregation during placement. A properly designed, uniform ($D_{90}/D_{10} < 3$ to 4) filter sand may be placed without tremieing if it is poured in around the screen in a heavy continuous stream to minimize segregation. The tremie pipe should be at least 2 in. in diameter, be perforated with slots 1/16 to 3/32 in. wide and about 6 in. long, and have flush screw joints. The slots allow the filter material to become saturated, thereby breaking the surface tension and preventing "bulking" of the filter in the tremie. One or two slots per linear foot of tremie is generally sufficient. To avoid contamination by iron bacteria, the filter should be washed through the tremie pipe using a 100-ppm chlorine solution. The tremie pipe is lowered to the bottom of the open drill hole, outside the well screen and riser pipe. The presence of centering devices will interfere with the proper use of the tremie by preventing uniform filling to some extent. The use of dual diametrically opposed tremie pipes will ensure more uniform placement. After the tremie pipe or pipes have been lowered to the bottom of the hole, they should be filled with filter material and then slowly raised to keep them full of filter material at all times. Extending the filter material at least 2 ft above the top of the screen will depend on the depth of the well to compensate for settlement during well development. The top of the filter should also terminate below the bottom of the overlying top stratum if present. The level of drilling fluid or water in a reverse-rotary drilled hole must be maintained at least 7 ft above the natural ground-water level until all the filter material is placed. If a casing is used, it should be pulled as the filter material is placed, and the bottom of the casing kept 2 to 10 ft below the top of the filter material.

8-9. Development

A well is at best inefficient until properly developed. Development procedures include both chemical and mechanical processes. Development of a well should be accomplished as soon after the hole has been drilled as practicable. Delay in doing this procedure may prevent a well being developed to the efficiency assumed in design.

8-10. Chemical Development

Chemical development is applied usually in the case where special drilling fluids are utilized and chemicals are injected into the well to aid in the dissolution of the residual drilling fluid in the filter. The chemicals should be of a type and concentration recommended by the manufacturer of the drilling fluid. They should be placed starting at the bottom of the well and dispersed throughout the entire screen length by slowly raising and lowering the injection pipe. After the chemicals have been dispersed, the well should be pumped and the effluent checked to ensure that the drilling fluid has completely broken down.

8-11. Mechanical Development

The purpose of mechanical development is to remove any film of silt from the walls of the drilled hole and to develop the filter immediately adjacent to the screen to permit an easy flow of water into the well. The result of proper development is the grading of the filter from coarsest to finest extending from the well. The effect of proper development is an increase in the effective size of the well, a reduction of entrance losses into the well, and an increase in the efficiency of the well. Many factors, including but not limited to development methods, well design, and filter installation, affect the time it takes to fully develop a well. Basically there are three methods used in development as discussed below.

a. Water Jetting. A water jet, consisting of a series of small nozzles at the end of a pipe, lowered into the well screen, is very effective in developing the continuous slot-type, wire-wrapped screens. A typical water jet is shown in Figure 8-3. Water is pumped down and out through the nozzles at a high velocity. Nozzles are directed toward the screen slots in small concentrated areas, as shown in Figure 8-4. The water jet equipment can be fabricated in local welding shops. The size and number of nozzles must be consistent with the size and length of the pipe through which the water is pumped to ensure a high-pressure and high-velocity jetting action. This method requires a high-pressure, relatively high-volume water pump. The lowest effective nozzle velocity for water jetting is about 100 fps. Better results are obtained with nozzle velocities between 150 and 300 fps. Normally, development with a water jet is started at the bottom of the screen. Jetting is accomplished at one depth with the jet rotated for a fixed period of time. The jet is raised approximately 0.5 ft; rotation and jetting is continued for another fixed period of time. For the most effective jetting, the wells should be pumped or airlifted during jetting to remove the fines as they are dislodged by the jetting. This process is continued until the entire well screen has been jetted. The jetting tool should be continuously in motion since a small amount of sand is disturbed and may cause localized erosion of the screen. Jetting must be repeated a number of times to ensure optimum development of the well.

b. Surging. A surging block is a plunger consisting of one or more stiff rubber or leather discs attached to a heavy shaft. These discs should be about 1 in. smaller in diameter than the screen ID. A typical surge block is shown in Figure 8-5. Surging consists of moving water in and out of the screen using the up and down motion of the surge block through short sections of the well screen. The well should always be pumped or bailed to ensure a relatively free inflow of water prior to surging. Surging should begin with a slow and gentle motion above the well screen and continue with more vigor from the top of screen downward. This method is less effective than the water jet described above in continuous slot screens and more effective in screens with widely separated slots and louvered or shielded slots. The surging block should be pulled at approximately 2 fps for effective surging. For record keeping

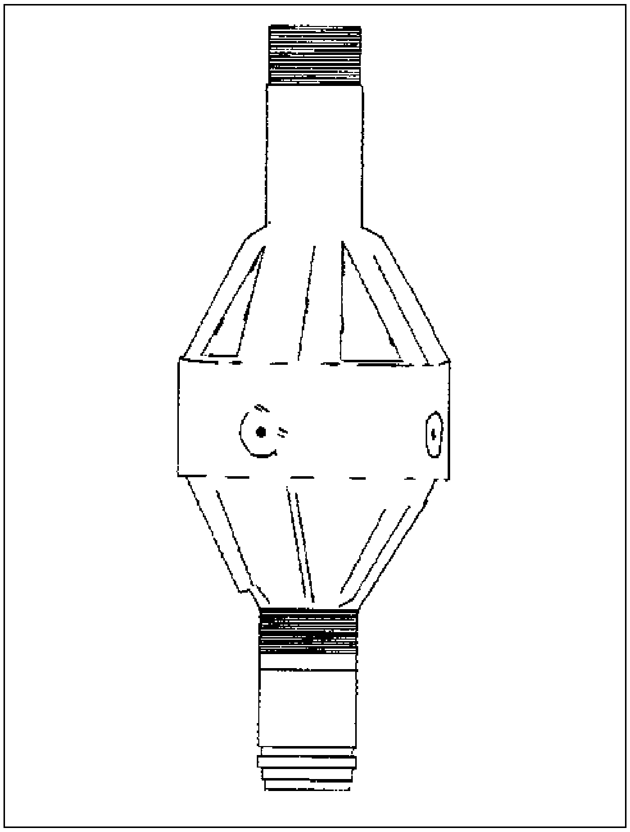

Figure 8-3. Schematic of four-nozzle jetting tool designed for use unside 8-in well screen for jet development

purposes, it is convenient to use 15 round trips as one cycle. The amount of material deposited in the bottom of the well should be determined after each cycle (about 15 trips per cycle). Surging should continue until the accumulation of material pulled through the well screen in any one cycle becomes less than about 0.2 ft deep. The well screen should be bailed clean if the accumulation of material in the bottom of the screen becomes more than 1 to 2 ft at any time during surging, thenrecleaned after surging is completed. Material bailed from a well should be inspected to see if any foundation sand is being removed. If the well is oversurged, the filter maybe breached with resulting infiltration of foundation sand when the well is pumped.

c. Pumping. One of the least effective and slowest methods of developing a well is simply pumping from the well. Pumping should be accomplished at a sufficient rate to effect maximum drawdown in the well.

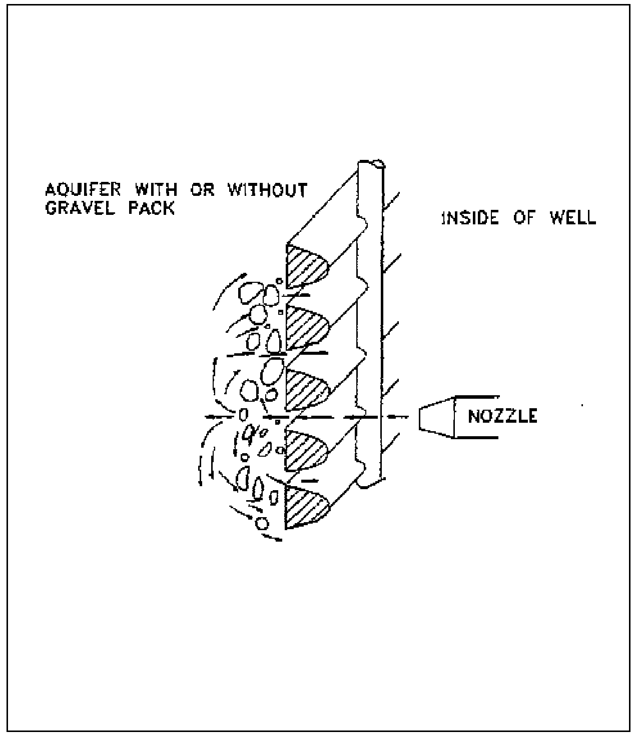

Figure 8-4. Well development by high-velocity jetting (after Driscoll 1986)

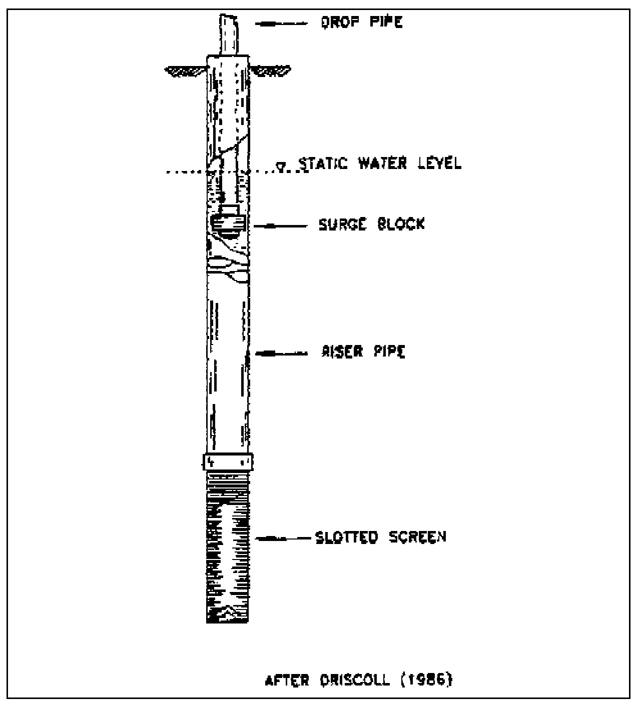

Figure 8-5. Development with a surge block (after Driscoll 1986)

The water passing from the formation through the filter into the well removes part of the finer fraction of the filter material. The pumping equipment required depends on the size, yield, and anticipated drawdown in the well. Surging produced by repeatedly starting and stopping a pump is only effective where the static water level is well below the ground surface. Pumping, continued over a long period of time, is a reasonably effective method of well development. Pumping of the well is normally accomplished by inserting a pipe in the well and forcing compressed air to the bottom of the well. If the depth of submergence of the pipe is at least 50 percent of its length, air bubbles reduce the weight of the water column and will cause a flow to the ground surface. If 50 percent submergence is not possible, the water column which must be physically blown out of the well as it accumulates will require a large supply of air. Pumping can be accomplished using a mechanical pump, but granular material in the water can cause damage.

8-12. Sand Infiltration

During the development process, sand and silt will be brought into the well. When the depth of sand collected in the bottom of the screen reaches 1 ft, it should be removed by bailing. The accumulation of sand in the screen prevents development of that portion of the screen. A properly developed well will not produce an appreciable amount of sand, and entrance losses through the filter will be reduced to a minimum. In each of the methods discussed above, the actual amount of development must be recorded: the length, diameter, speed, and number of cycles of a surging block; the volume, pressure, and diameter of water jets; and the rate and method of pumping and length of time pumped. In addition, the amount of filter and foundation materials brought into the well and bailed out should be recorded. Upon completion of the development of the well, all material infiltrated into the well should be bailed out. The well should be pumped to achieve a drawdown in the order of 5 ft in the well. If the well produces sand during pumping in excess at approximately 2 pints per hour (as determined from sounding and from collection of well flow in a 10-gal container) the well should be resurged or developed further and repumped. Wells continuing to produce excessive amounts of sand after 4 to 8 hours or surging or pumping should be abandoned and properly plugged.

8-13. Testing of Relief Walls

Performance of relief wells properly installed and developed is determined by pumping tests. The pumping test is used primarily to determine the specific capacity of the well and the amount of sand infiltration experienced during pumping. The information from this test is required to determine the acceptability of the well and will be used to evaluate its performance and loss of efficiency with time. The results of this pumping test must be made a part of the permanent record concerning the well.

a. Equipment. The equipment required for a pumping test consists of a pump of adequate size to effect a substantial drawdown. If the water level in the well is near enough to the ground surface, and the specific capacity of the well is high enough to produce a substantial flow with a small drawdown, a centrifugal pump may be used for this purpose. If the water level in the well is lower than about 18 to 20 ft, a deep-well pump will be required to effect substantial drawdown. A flow meter is required to measure the flow rate. A flat-bottom sounding device and a steel tape are required to determine the amount of sand infiltration deposited in the bottom of the well. A suitable baffled stilling basin is used to determine the amount of sand in the effluent. A sounding device suitable for determining the depth to the top of the water is needed to find the exact drawdown in the well. A well flow meter is desirable to measure the amount of flow at various depths within the well to define flow from various zones.

b. Pumping. The well must be pumped to obtain a specified drawdown or flow rate. Drawdown measurements in the well should be made to the nearest 0.01 ft and recorded with the flow rate at 15-minute (min) intervals throughout the duration of the tests. Sufficient sand infiltration determinations are necessary to establish an infiltration rate for each hour of the pumping test. The rate of sand infiltration may be determined from sounding and measurements of sand in the effluent. For most properly developed wells, the amount of sand deposited in the well will be negligible and sand infiltration in the effluent can be recorded in terms of parts per million (Note: sand infiltration in parts per million is approximately equal to pints per hour times 3,000 divided by the pumping rate in gallons per minute) as measured with a centrifugal sand tester or other approved sediment concentration test (Driscoll 1986). The length of time that the pumping test must be continued is normally specified for the particular project. If the rate of sand infiltration during the last 15 min of the pumping test is more than 5 ppm, the well should be resurged by manipulation of the test pump for 15 min; then the test pumping should be resumed until the sand infiltration rate is reduced to less than 5 ppm. If after 6 hours (hr) of pumping the sand infiltration rate is more than 5 ppm, the well should be abandoned.

8-14. Backfilling of Well

After completion of the well testing, the annular space above the top of the filter gravel should be filled with filter gravel if necessary to achieve design grade. The remainder of the hole should be filled with either a cement-bentonite mixture tremied into place or concrete where the height of drop does not exceed 8 ft. In both cases, a 12-in. layer of concrete sand or excess filter material should be placed on top of the filter before placement of grout or concrete. A tremie equipped with a side deflector will prevent jetting of a hole through the sand and into the filter.

8-15. Sterilization

Upon completion of the pumping tests and before installation of the well cover, each well should be sterilized by adding a chlorine solution with a minimum strength of 500 ppm. Sufficient solution should be added to the bottom of the well to provide a volume equal to three times the volume of the well based on the outer diameter of the filter. Before the solution is introduced into the well, all flow from the well should be stopped with inflatable packers or riser extensions. The solution should be injected into the well through a jetting tool by slowly raising and lowering the tool through the screened portion of the well. The well should be gently agitated at 10-min intervals every 2 hr for the first 8 hr and then at 8-hr intervals for at least 24 hr. As the chlorine will dilute with time, the concentration should be periodically checked; if it falls below 500 ppm, additional chlorine compound should be added. It should be noted that calcium hypochlorite may combine with naturally occurring calcium in the ground water to form a precipitate of calcium hydroxide which can plug the pores of the foundation soils. Therefore, chlorine in the form of calcium hypochlorite should not be used in waters containing high calcium content.

8-16. Records

Permanent records of the installation, development, testing, and sterilization of a permanent relief well must be kept for evaluation of future testing. To monitor the efficiency and performance of the installation, the record must include identification of the well, method of drilling, type, length and size of well screen, and slot size. The filter should be defined as to grain-size characteristics, depth, and thickness. Elevation of the top of the well and the ground surface should be recorded. An abbreviated log of the boring should be included to define the depth to granular material, the thickness of that material, and the percent penetration of the well. Development data should include the method of development, the amount of effort expended in development, and the amount of materials pulled into the well during development. The record should show the final sounded depth of the well in case some fines remain at the bottom. The pumping test data should include the rate of pumping, the amount of drawdown, the length of time the pumping test was conducted, and the amount of sand infiltration during pumping. Installation and pumping test data should be recorded on forms similar to that shown in Figures 8-6 and 8-7. Forms should be filled in completely at the time each operation is completed and any additional observations should be recorded in a "remarks" section.

8-17. Abandoned Wells

Wells that produce excessive amounts of materials during pumping tests or that do not conform to specifications and can not be rehabilitated should be abandoned. Abandoned wells should be sealed to eliminate physical hazards, prevent contamination of ground water, conserve hydrostatic heads in aquifers, and prevent intermingling of desirable and undesirable waters. Primary sealing materials consist of cement or cement-bentonite grout placed from the bottom upward. In general, abandoned wells should be sealed following procedures established by local, state, or Federal regulatory agencies.

RELIEF WELL INSTALLATION REPORT

PROJECT: | LEVEE DISTRICT:

LOCATION (STA): | OFFSET FROM CENTER LINE: | WELL NO.:

DRILLING METHOD: | DATE AND TIME:— FROM: TO:

WELL SCREEN:—TYPE: INSIDE DIAM: PERFORATIONS:

RISER:—TYPE: INSIDE DIAM: | FILTER:

TYPE OF WELL GUARD: INSIDE DIAM: | TYPE OF BACKFILLLL:

CONTRACTOR: | CONTRACT NO.: | FOREMAN: OPERATOR:

GROUND ELEV AT WELL: | DEPTH TO:— Fine Sand: Medium to Fine Sand:

ELEV TOP OF RISER: | ELEV TOP OF WELL GUARD: | ELEV TOP OF CONCRETE BACKFILL:

TYPE OF CHECK VALVE: | WELL EXTENSION:— Type: ;Ht:

FINAL WELL INSTALLATION DATA

RISER PIPE LENGTH:	INSIDE DEPTH OF WELL:
"EXTRA" SCREEN LENGTH:	DEPTH OF SAND IN WELL AFTER CLEANING:
"DESIGN" SCREEN LENGTH:	ELEV TOP OF WELL SCREEN:
TOTAL SCREEN LENGTH:	ELEV TOP OF FILTER:
"BLANK" PIPE LENGTH:	INSIDE BOTTOM ELEV OF WELL:
DEPTH OF HOLE:	ELEV RISER SET AT:

SURGING DATA

METHOD: | DATE AND TIME: | TOTAL SURGING TIME:

GRAVEL IN WELL BEFORE SURGING: | MATERIAL SURGED. IN:— | SURGING CYCLE | #1: | #2: | #3:

SURGING CYCLE | #4: | #5: | #6: | #7: | #8: | TOTAL:

SETTLEMENT OF FILTER DURING SURGING:

PUMPING DATA

RATE OF PUMPING: | TOTAL PUMPING TIME:

RATE OF SAND INFILTRATION:—START: ;End:

REMARKS:

LOG OF HOLE	DEPTH	PIPE INSTALLED
	0	
	10	
	20	
	30	
	40	
	50	
	60	
	70	
	80	
	90	
	100	

WES FORM 797
MAR '53
REVISED OCT. '53

INSPECTOR

Figure 8-6. Relief well installation report 28

RELIEF WELL PUMPING TEST REPORT

PROJECT:	LEVEE DISTRICT:

LOCATION (STA):	ELEV TOP OF RISER:	WELL NO:
DATE:	TIME TEST STARTED:	TIME TEST COMPLETED:

TIME	ELAPSED TIME MINUTES	DEPTH TO WATER	DRAWDOWN IN FEET	FLOW IN GPM	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER	DRAWDOWN IN FEET	FLOW IN GPM
	0		0						

SAND INFILTRATION TEST

DEPTH OF WELL:	DEPTH TO SAND IN WELL BEFORE TEST:	SAND IN WELL BEFORE TEST:

TEST NO.	TIME	DEPTH TO SAND (FT)	SAND IN WELL (PTS)	GAIN OR LOSS OF SAND IN WELL (PTS)	SAND PUMPED OUT OF WELL (PTS)	TOTAL INFLOW OF SAND INTO WELL (PTS)	LENGTH OF TEST (MIN)	RATE OF SAND INFILTRATION (PTS, HR)

DEPTH TO SAND IN WELL AFTER TEST:	SAND IN WELL AFTER TEST:	SAND IN WELL AFTER CLEANING:

REMARKS:

WES FORM 796
MAR '53
REVISED OCT '53

INSPECTOR

Figure 8-7. Relief well pumping test report